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Abstract

RESEARCH ON COMMERCIAL MIXTURES OF HYDROCARBONS FOR USE AS MODERATOR-COOLANTS IN REACTORS

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During the first phase of this programme, a study was made of three commercial mixtures of terphenyls (PROGIL OM1, OM2 and OMP) and three mixtures of partially hydrogenated terphenyls (MONSANTO HB-40 and HB-20 and PROGIL OMP-H). The tests were mainly concerned with studying the thermal and radiation behaviour of these substances and investigating the effect of thermal and radiolytic damage on their principal physical properties.

Information was obtained on the thermal-decomposition kinetics of polyphenyls by means of static pyrolytic tests carried out at various temperatures between 400 and 500°C. The following determinations were made as a function of temperature for various materials: the initial formation rate of different gases (hydrogen, methane and other homologous hydrocarbons); the initial formation rate of liquids and solids possessing greater volatility than the original components (benzene, alkyl benzenes, cyclohexane, biphenyl, alkyl biphenyls, etc.); the initial formation rates of polymers; and the initial disappearance rates of the starting compounds. For this purpose, the kinetic orders of the thermal breakdowns were determined and the corresponding activation energies were recorded. In each case, variations in density, viscosity and melting point were studied as a function of polymer content or other decomposition values.

Parallel radiolytic studies, also static, were made with electrons accelerated (1 MeV) in a Van de Graaff generator. Results for this work are still incomplete so that no definite conclusions can be drawn.

On the basis of purely pyrolytic data and relative values for fabrication costs, the paper indicates provisional criteria applicable to the selection of the materials tested.

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Abstract

PRODUCTION OF STABLE ISOTOPES IN SPAIN

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The paper describes work carried out under the stable-isotope-production programme on the separation of stable isotopes by ion-exchange chromatography and thermal diffusion. With the former technique, a study was made of the separation of N^{14}, N^{15}, B^{10} and B^{11}. This work included laboratory-scale experiments carried out with a view to determining the separation factor by means of the breaking-point technique.

For nitrogen, use was made of ammonium hydroxide, chloride and acetate; only the first of these proved suitable for obtaining a good separation. Experimental conditions, e.g. flux velocity and concentration, were varied so as to ascertain their influence on the separation factor. Use was made of the strongly acidic cationic resin Dowex 50W (100-200 mesh). In the favourable case of ammonium hydroxide the values for the separation factor varied between 1.028 and 1.022, depending upon experimental conditions.

In the case of boron, the strongly basic resins Dowex 1 and Dowex 2 (100-200 mesh and 200-400 mesh) were used to study boric acid and sodium borate compounds and complexes of boric acid with mannite and glycerine. The highest separation factor was obtained with boric acid (1.035-1.027, depending upon concentration); reasonable values were also found with mannite (1.024) and glycerine (1.027) complexes. With sodium borate, the separation factor diverges only slightly from unity.

In the case of both nitrogen and boron, these experiments confirm the need for employing complexes of these substances that are slightly ionized in solution in order to obtain separation factors appreciably different from unity.

Laboratory experiments were carried out to study the separation of nitrogen and boron isotopes by means of displacement development chromatography. In the case of nitrogen, a band of ammonium hydroxide was fixed on a cationic resin in hydrogen form and was displaced by sodium hydroxide. For boron, a boric-acid band was fixed on an anionic resin in OH form and displacement carried out by means of acetic acid.

A pilot plant for the separation of stable isotopes by means of ion-exchange chromatography has been built; this installation is automatically controlled and is designed for continuous operation.

In the course of the thermal diffusion investigations, a study was made of the separation of the various isotopes of the noble gases, oxygen, nitrogen and carbon-13. The object of this work was to: (a) correlate theoretical and experimental data in different types of column; (b) determine the thermal diffusion co-efficients of isotopic mixtures in cylindrical columns and study the distribution of multi-component mixtures with a view to discovering gases capable of acting as "filters".

A 90° sector mass spectrometer has been built for measuring isotope abundance ratios between 1 and 400 amu.

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Abstract

RESEARCH REACTORS IN SPAIN

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There are now in Spain three Research Reactors: JEN-1 at the National Centre of Nuclear Energy in Madrid, ARGOS at the Technical School of Industrial Engineers in Barcelona and ARBI at the Technical School of Industrial Engineers in Bilbao. The first one is an American swimming pool type reactor working at a maximum power of 3 MW; it first became critical at the end of 1958. The other two are Argonaut type reactors, were constructed in Spain and went into operation at the middle of 1962.

In this report the activities of these reactors are described; including first, data concerning the organization of the reactors themselves and their relation with the centres where they are located.

Among the activities of these reactors, the operation problems are briefly discussed. These problems were specially important at the beginning; afterwards the training activities of students have been playing an important role in some of these reactors. The technical research has been basicaly instrumentation tests, such as ionization chambers and other neutron detectors as well as the irradiation of some fuel elements. One outstanding application of the swimming pool reactor has been the isotope production. In this field the production of I^{131}, Au^{198} and P^{32} has become very

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important. Also interesting studies were accomplished using the activation analysis techniques.

As far as pure research in concerned the reactors have been used for neutron physics studies; this subject is still a fruitful field of research. Finally it is worth to mention the applications in the field of pure Nuclear Physics and Solid State Physics that, although recently started, show already some interesting results.

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Abstract

FUEL ELEMENTS STUDIES AT THE JUNTA DE ENERGIA NUCLEAR

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This paper describes the main lines of effort at the Metallurgy Division of the J.E.N. As far as core materials are concerned metallic uranium, uranium dioxide and uranium monocarbide production techniques have been developped. There is also small group working on the fabrication of aluminium clad fuel plates for the J.E.N. research reactors of Argonaut and swimming pool type.

Work on metallic uranium has covered the production of UF_4, preparation of uranium ingots by calcium reduction of uranium tetrafluoride and fabrication of uranium bars by vacuum casting and by extrusion. Some work has been also carried out on the effect of thermal and mechanical treatments on uranium bars and on the influence of minor alloying constituents.

Work on UO_2 has dealt with the preparation of suitable powders for sintering purposes and production of uranium monocarbide by corbothermic reduction of UO_2. Each one of this powders requires different properties. The effect of fabrication variables on the final characteristics of the powders have been evaluated.

Uranium carbide production by arc melting and casting has been studied. UC feed stock is prepared either from UO_2 or from uranium scrap from the machinning of uranium bars.

Work on aluminium clad fuel plates has been restricted to

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elements with U_3O_8 -Al dispersion cores.

Some effort has been spent on the preparation on refractory ceramic materials. Special type corrosive resistant to gaseous hydrofluoric acid ceramic materials have been developped.

Welding studies have been concerned mainly with aluminium and aluminium alloys, magnesium base alloys and stainless steel.

On the non destructive field X-ray and ultrasonic testing facilities are available. Work on eddy current methods is also in progress.

Hot cell laboratories will be in operation in 1964 - 65. They will include a 1.000 C cell and a line of lead shielded glove boxes.

All work at the Metallurgy Division of the J.E.N. is oriented towards the installation of complete fuel fabrication facilities whenever the reactor program will require it.

The paper describes the facilities available at present or in the near future with emphasis on the technical characteristics of the equipment and production capacity.

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Abstract

URANIUM IN SPAIN: PRESENT SITUATION AND PROSPECTS

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Spain initiated the prospecting for uranium and Thorium about 1948 and, since that time, a large portion of the surface of the country has been prospected and studied. This work has been accomplished largely by the J.E.N. with some assistance, in some cases, from private groups or companies.

The results obtained to this date have permitted the establishment of known uranium reserves of more than 6,000 metric tons of contained U_3O_8, recoverable at present market prices. These reserves increase considerably at higher levels of recovery costs. In the case of thorium the results to date have not been very satisfactory, having been limited to small quantities.

In this paper is presented a description of the work completed to date and the results obtained in the various regions studied. The methods of prospecting and investigation followed are presented in detail and some economic data related to the area explored and the reserves discovered are given.

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Since the exploitation of several mines has been initiated to provide feed material for an ore concentration plant, comparative technical and economic data related to various exploitations and treatment of various ore types are also given.

The future prospects for the mining of uranium in our country are examined in view of the results obtained to date.

Finally, the present uranium reserves in Spain are compared with our needs in future years according to the program described in another paper presented at this Conference.

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Abstract

SAFETY FEATURES OF THE DON REACTOR CONCEPT

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The DON is a heavy-water-moderated, organic-cooled, natural-uranium-fueled type of reactor. A 30 MWe version of this concept is presently being studied by the J.E.N. to serve as a prototype for large nuclear power plants.

Safety analyses of this prototype have been published containing theoretical and experimental work and this work is continuing. In these studies the safety aspects of the whole reactor concept are analyzed.

The reactor is a low pressure system due to the physical properties of the organic and the operating conditions of the moderator, this being one of the major advantages of this reactor concept.

Equations have been developed and programmed to describe the release of radioactive contaminants to the atmosphere from credible accidents. Different types of containment schemes are analyzed to prove that simple engineering features are enough to reduce the release below the permissible limits.

Mechanical and thermal barriers have to be located within coolant and moderator. The integrity of these barriers has to be maintained throughout the reactor life, thus posing a problem to be studied. A preliminary chemical compatibility study among the various components suggested for the DON prototype shows that no hazardous chemical reactions are likely to occur.

Reactor stability and its influence on nuclear accidents are discussed. The radiological consequences of reactor operation are analyzed to prove that reactors of this type can be built and operated in normal locations without undue risk to the health and safety of the public and without adding costly or novel engineering safety features.

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Abstract

J.E.N. STUDIES ON THE HEAVY WATER PRODUCTION BY ELECTROLYSIS AND ISOTOPIC EXCHANGE REACTION

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The studies carried out by the J.E.N. on the heavy water production by electrolysis and isotopic exchange in order to utilize the facilities of a water electrolysis plant owned by the fertilizer company E.I.A.S.A. are described.

The studies were developed in the following stages: 1º) Theoretical study of the ideal cascade with electrolysers and reactors for the isotopic exchange reaction H_2O/H_2 utilizing as feed water vapor with a deuterium concentration as in Nature. 2º) Theoretical study of square cascades by means of a computer UCT - UNIVAC. 3º) Project, commissioning and starting up of the modification of the industrial electrolysis plant. 4º) Project, commissioning and starting up of the electrolysis and burner pilot plant and of the rectification pilot plant to enrich the product of the industrial plant. 5º) Analytical methods of control for all the ranges of concentration of the industrial and the pilot plants.

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